

Ethyl Oleate Sprays to Reduce Cracking of Sweet Cherries¹

W. O. Harrington², Claude H. Hills², Susan B. Jones, A. E. Stafford³, and B. R. Tennes^{4,5}

Federal Research, Science and Education Administration, U.S. Department of Agriculture. Eastern Regional Research Center⁶ Philadelphia, PA 19118

Additional index words. *Prunus avium*

Abstract. Spraying with 3% ethyl oleate (EO) reduced the incidence of cracking from 29 to 11% in 'Vista' cherries (*Prunus avium* L.). Applications of EO increased the rate of dehydration in cherries exposed to ambient air following treatment. Scanning electron microscopy (SEM) observations suggest that EO modifies the cherry cuticle by redistributing surface wax, thereby enhancing mass transfer of water vapor through the skin.

Serious losses of sweet cherries due to cracking are common in areas where rains occur near harvest. Levin et al. (5) estimated that the average loss of sweet cherries in Michigan was 15 to 20%, but losses as high as 90% have occurred in some orchards during rainy, hot, and humid weather. Partially because of the high risk of cracking, only 5% of the sweet cherries in the East are grown for fresh market (11).

Cracking usually occurs within a few hours following a rain. Davenport (4) has shown that the principal cause of cracking is absorption of water through the cherry skin. Cracking is influenced by cultivar, fruit maturity, humidity, and temperature (1, 3). Orchard sprays of calcium salts and other chemicals have been used with limited success (1, 2, 5, 8, 10, 12, 13). None of these is used commercially.

Ponting and McBean (7) used emulsions of various fatty acid esters to speed up the drying of grapes and other waxy fruits. More recently, Petrucci et al. (6) used 1% to 2% methyl oleate sprays to accelerate drying of grapes for raisin production. Preliminary studies carried out by the senior author in 1972 demonstrated that the incidence of cracking in sweet cherries could be reduced by spraying with an ethyl oleate (EO) emulsion.

In the present study, we evaluated the effectiveness of EO sprays in preventing cracking of sweet cherries under orchard conditions to better understand the mechanism of EO action.

1974 trials. Twelve trees of Vista, a highly crack-susceptible cultivar, in the McLachlan Orchard, Kewadin, Michigan, were selected for study. Three trees

each were sprayed with 1, 2 or 3% emulsion of EO in water by means of a Solo⁶ air blast power sprayer. Three trees, not sprayed, served as controls. The cherries were within 5 to 10 days of full maturity for fresh market. Five days later, following an overnight rain of 3.8 cm, about 200 cherries for each treatment was sampled to determine the percentage of cracked fruit.

The % cracked fruit was 29.3 in the control, 26.0 with 1% EO, 22.3 with 2% EO and 11.3 with 3% EO. There was only a slight reduction in the percentage of cracked cherries with 1% and 2% EO, but a sizeable reduction was achieved with the 3% EO spray. There was a slight wilting of the foliage for a few days and then complete recovery of most leaves. A few leaves dropped from each of the sprayed trees.

Samples of fruit from the 3% EO treatment were frozen and later extracted with CHCl₃; the hexane-soluble fraction of the CHCl₃-extracted residue was analyzed for EO by the method of Stafford et al. (9) The results showed residues of less than 5 ppm of EO.

In an effort to understand the effect of EO on the fruit, we dipped samples of 50 unsprayed, mature 'Vista' cherries in the EO emulsions for 1 min and then allowed them to dry on paper plates at room temp. EO caused a marked increase in the drying rate (Table 1), the rate for the 4% EO emulsion being nearly double that for the control. The tendency for cherries to become dehydrated following treatment indicated a potential postharvest handling problem which would require further study.

In a separate experiment, we soaked 10 EO dipped cherries and 10 controls in tap water at room temp and weighed

¹Received for publication November 25, 1977.

²Eastern Regional Research Center, retired.

³Western Regional Research Center.

⁴Science and Education Administration, Michigan State University, E. Lansing, Michigan.

⁵We thank Mrs. Ruth D. Zabarsky (ERRC) for assistance with the photography, Mr. Franklin P. Rorer (ERRC) for assistance in the microscopy, Therese M. Dougherty for assistance with the analyses, and Mr. Richard Wolthuis and Dr. Clyde L. Burton (ARS-Michigan State University) for participation in the orchard trials. We also acknowledge the cooperation of Styer Brothers Orchards and McLachlan Orchards in providing facilities for our orchard trials.

⁶Reference to branch or firm names does not constitute endorsement by the U.S. Department of Agriculture over others of a similar nature not mentioned.

Table 1. Drying rate of 'Vista' cherries dipped in ethyl oleate.

Ethyl oleate concn (%)	% wt loss	
	18 hr	80 hr
0	3.4	10.1
1	4.2	12.4
2	3.9	13.2
4	6.1	19.5

them at intervals up to 24 hr. The EO dipped fruit gained weight twice as fast as the controls. Thus, under conditions of prolonged rainy weather, EO sprayed fruit might conceivably show an increased tendency to crack due to water uptake through the cuticle.

1976 trials. Additional studies were made in 1976 with 'Windsor' sweet cherries from Styer Brothers Orchards, Langhorne, Pa. Trees were sprayed with 2% and 4% EO, by use of a small 90 liter (20 gal) power sprayer. Sufficient spray was applied to cause the foliage to drip. There was no rain during the 10 days between spray application and harvest, and none of the fruit cracked. Various samples were obtained for further study of the effects of EO on the fruit.

The drying rates of cherries harvested from the unsprayed trees (controls) and from the EO sprayed trees were determined on duplicate lots of 10 cherries and compared to similar numbers of unsprayed cherries dipped 1 min in 4% EO (Table 2). The EO sprayed fruit showed an increase in drying rate proportional to the concn of the spray. Dipping gave a higher drying rate than spraying with the same concn.

Scanning electron microscopy. Tangential sections (5 × 5 × 2 mm) of control and EO-treated 'Windsor' cherries from the 1976 trials were cut with a razor blade. Specimens were rinsed with distilled H₂O to remove juice and were then frozen in liquid N₂, and dried overnight at 0.3 atmosphere in a vacuum evaporator. Dried specimens were mounted on stubs by means of silver conductive paint and were coated with about 15 nm of gold-palladium (60/40). Specimens were observed in a JEOL 50A Scanning Electron Microscope equipped with the lanthanum hexaboride electron gun, operating at an accelerating voltage of 15 KV.

Surface wax in control 'Windsor' cherries (Fig. 1a) appears to form a continuous layer over the cuticle, showing ridges where underlying epi-

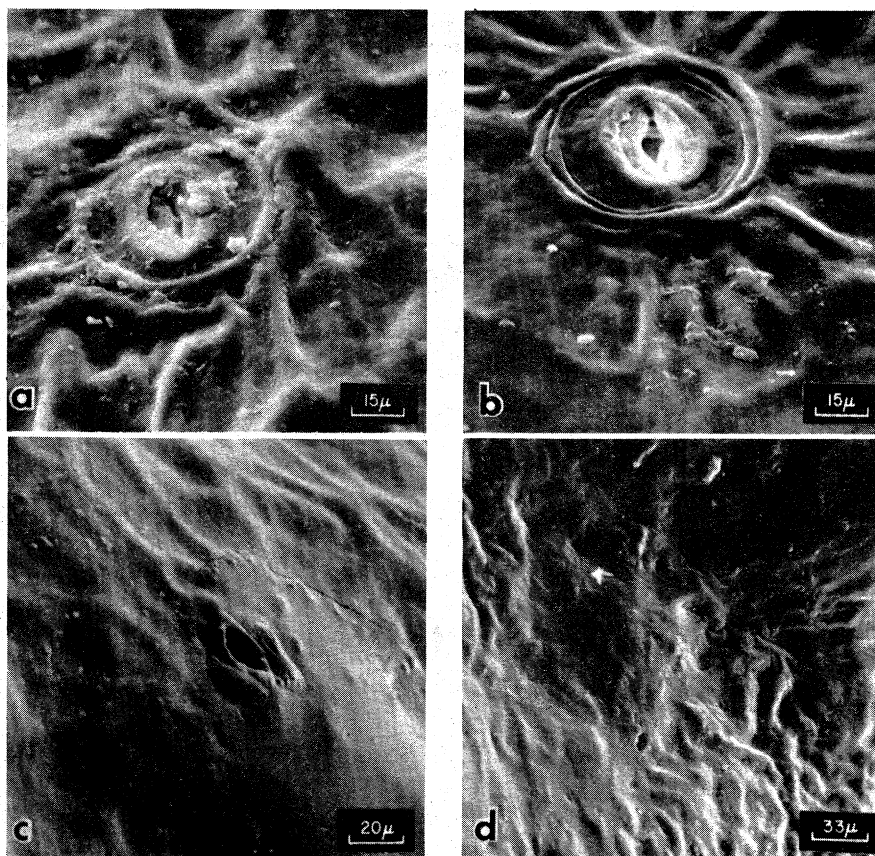


Fig. 1. Scanning electron micrographs of Windsor cherries: a. control, b. dipped in 4% EO, c. and d. sprayed with 4% EO.

dermal cell walls meet the cuticle. The wax is thicker over guard cells (immediately surrounding the stomata) than over the cuticle in general and often partially or wholly obstructs the stomata. Cherries dipped in 4% EO appeared to have little or no wax on the cuticle or around the stomata (Fig. 1b); the surface is similar to that of a cherry which has been dewaxed with chloroform (not shown). Cherries sprayed with EO emulsions showed no visible effects over much of the surface scanned. However, on some sprayed samples (Figs. 1c and 1d), wax appeared to have been moved about on the surface and formed into flow patterns distinctly different from the usual appearance of the wax. These findings may reflect the random selection of individual cherries and areas of cherry surface to be examined by SEM as well as the random deposit of spray on cherry surfaces.

These observations suggest that the effect of EO on sweet cherries may be to redistribute wax on the surface, thereby enhancing mass transfer of water vapor through the partially dewaxed areas of the cuticle.

Literature Cited

1. Bullock, R. M. 1952. Studies on some inorganic compounds and growth-promoting chemicals in relation to fruit cracking of Bing cherries at maturity. *Proc. Amer. Hort. Sci.* 59:243-253.
2. Christensen, J. V. 1972. Cracking in cherries. The influence of some salts and chemicals on the cracking susceptibility. *Saertrykk av Frukt og Baer. Landbruks-*

forlaget, Oslo, p. 2-12.

3. Christensen, J. V. 1972. Cracking in cherries II. The influence of climatic conditions on cracking susceptibility. *Tidsskr. Planteavl* 76:191-195. [*Biol. Abstr.* 27948. 1973.]
4. Davenport, D. C., K. Uriu, and R. M. Hagen. 1972. Antitranspirant film: curtailing intake of external water by cherry fruit to reduce cracking. *HortScience* 7:507-508.
5. Levin, J. H., C. W. Hall, and A. P. Deshmukh. 1959. Physical treatment and cracking of sweet cherries. *Mich. Agr. Expt. Sta. Quart. Bul.* 42:133-141.
6. Petrucci, V., N. Canata, H. R. Bolin, G. Fuller, and A. E. Stafford. 1974. Use of oleic acid derivatives to accelerate drying of Thompson seedless grapes. *J. Amer. Oil Chem. Soc.* 51(3):77-80.
7. Ponting, J. D., and D. M. McBean. 1970. Temperature and dipping treatment effects on drying rates and drying times of grapes, prunes and other waxy fruits. *Food Tech.* 24(12):85-88.
8. Powers, W. L., and W. B. Bollen. 1947. Control of cracking of fruit by rain. *Science* 105:334-5.
9. Stafford, A. E., G. Fuller, H. R. Bolin, and B. E. Macker. 1974. Analysis of fatty acid esters in processed raisins by gas chromatography. *Agr. & Food Chem.* 22:478.
10. Tennes, B. R. 1973. Physical properties of fruit related to cracking. PhD Thesis, Michigan State Univ., East Lansing.
11. U.S. Department of Agriculture. 1973. Agricultural statistics. U.S. Government Printing Office, Washington, 1973.
12. Verner, L. 1938. Reduction of cracking in sweet cherries following the use of calcium sprays. *Proc. Amer. Soc. Hort. Sci.* 36:271-74.
13. Westwood, M. N., and H. O. Bjornstad. 1972. Sprays to prevent rain cracking of sweet cherries. *Proc. Oregon Hort. Soc.* 63:79.

Table 2. Effect of ethyl oleate spray or dip on rate of moisture loss from Windsor cherries.

Treatment	% wt loss, 21 hr
Control	5.2
Sprayed, 2% EO	7.4
Sprayed, 4% EO	9.4
Dipped, 4% EO	21.5